Description of Accuracy Scenarios for the Acceptance Testing of the User Request Evaluation Tool (URET) / Core Capability Limited Deployment (CCLD)

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1 Introduction

1.1 Background

The Federal Aviation Administration (FAA) has contracted the Lockheed Martin Corporation Air Traffic Management Division (LMATM) to develop and deploy a Conflict Probe Decision Support Tool. The deployment is limited to seven Enroute Air Traffic Control Centers to meet the FAA's Free Flight Phase 1 objective. The limited deployment of the Conflict Probe application is called the User Request Evaluation Tool Core Capability Limited Deployment (URET CCLD). The URET CCLD application is based on the MITRE developed URET Daily Use (DU) system installed in Indianapolis and Memphis Centers.

The FAA has tasked the Traffic Flow Management Branch, ACT-250, at the FAA W. J. Hughes Technical Center at Atlantic City to supply LMATM scenarios of realistic air traffic to perform acceptance testing of their system. In particular, these scenarios are to support the accuracy testing and will be used to verify the accuracy requirements of URET CCLD.

AOS-610, in conjunction with ACT-230, ACT-250, and MITRE have collected air traffic data from the Indianapolis (ZID) and Memphis (ZME) Air Route Traffic Control Centers (ARTCCs). This data will be modified to produce the test scenarios. The data will be modified by shifting the start times of aircraft flights and possibly by cloning selected flights. These modifications are made to induce encounters between the aircraft in the test scenarios, but maintain the actual profiles the aircraft originally flew.

1.2 Purpose

This document describes how the scenarios of air traffic generated from air traffic data collected from the ZID and ZME ARTCCs will be analyzed and characterized. A companion document, *Description of the Methodology for the Generation of Accuracy Scenarios for Acceptance Testing of the URET CCLD*, describes how the scenarios will be generated from the field data and how the actual analysis will be done [9]. The formats of the data to be supplied to Lockheed Martin are also described in this reference [9].

1.3 Scope

The scope of this document is to describe how the test scenarios will be characterized and presents preliminary statistics on a sample of the scenario data. This includes the scenario characteristics in terms of the distributions of encounters, aircraft, air traffic, airspace, flight plan adherence, interfacility message flow, and deviations in weather forecasts. The basis of these scenario characteristics are those listed in the *Lockheed Martin Air Traffic Management (LMATM) SIG Issue 166* [5] and the FAA's *URET CCLD System Specification Document* [4]. These previously defined characteristics will be supplemented and modified by metrics recognized as significant by ACT-250 with the agreement of AUA-200.

For the most part, the techniques described in this document will be used to measure the scenario characteristics, planned for delivery in mid and late year 2000. However, there may be instances where ACT-250 may need to alter the technique of measurement described to better meet the overall objective of the task. If this occurs in any significant way, ACT-250 will communicate the change to those on the document distribution list.

1.4 Document Organization

The testing philosophy that drives the scenario development is first discussed. Next, the characteristics of the scenarios are defined. The definitions include detailed descriptions of the characteristics and constraints ACT-250 is planning to provide and accompany the accuracy scenarios. Each characteristic definition includes the objective of the characteristic, description of the metric defining the characteristic, the measurement design thresholds, and additional design considerations if they exist. Finally, an appendix includes preliminary results of a sample set of the actual measurement taken against the same source traffic data that will be used for the first accuracy scenario delivery (i.e. scheduled for July 2000). It also includes a listing of the current parameters and their values used in the scenario generation.

2 Testing Philosophy

The accuracy acceptance testing is designed to determine whether or not URET CCLD performs as well as the URET Daily Use (DU) prototype developed by MITRE. The primary accuracy measures are (1) the probability of false alerts, (2) the probability of missed alerts, (3) the conflict notification warning time, (4) the predicted conflict start time accuracy, and (5) the vertical trajectory prediction accuracy. An important secondary performance measure is the horizontal accuracy of the predicted trajectories. Therefore, the main purpose of the accuracy scenarios is to provide a sufficient quantity of encounters and reasonable coverage of the various other factors which may effect them.

For the accuracy scenario, the test will include running two instances of the URET CCLD application in interfacility mode in the ZME and ZID adaptations for May 20, 1999 chart cycle. For the accuracy test, the ZME instance is the system under test (SUT). The ZID application demonstrates the interfacility functionality during the test and its influence on accuracy. Since the SUT is based on the ZME instance, all the scenario characteristics are measured against the ZME traffic data, except for interfacility communication metrics.

Two formats of the accuracy scenarios will be delivered and run for the accuracy test. The scenarios in a 320 HCS Patch format will be tested with the URET DU system developed by MITRE. Using this test, trajectory accuracy will be measured by ACT-250 and provided to AUA-200, who will implement them into a specification refresh of the A-level accuracy values defined in the *URET CCLD System Specification Document* (SSD) [4]. The same scenarios in a CMS format will be run through URET CCLD by LMATM and measured against the specification for acceptance. The process details are provided in reference [9].

3 Scenario Characteristics

The source of the scenarios is 26 hours of actual traffic data recorded from the ZME and ZID. The characteristics of the scenario provide measurement of the coverage of potential real world situations captured in the accuracy scenarios. The primary constraint in generating these scenarios is that the path the aircraft actually flew is not altered in anyway. Therefore, ACT-250 has only one degree of freedom which is to change the start time of the flights, measured from the first HCS track report. There are three basic techniques to change the start times: (1) compressing the flights in time, (2) randomly adjusting the start times, and (3) cloning the flights which includes adjusting the start times as well [9]. The time compression technique will increase the general density of flights per unit time and does increase encounter situations. The random process of adjusting start times induces much more encounters but may or may not increase general density of flights. Cloning flights will provide both increased density and encounters, however it also alters the aircraft and air traffic distributions.

The following sub-sections define characteristics that will be provided with the accuracy scenarios. The only characteristic that can be considered a strict constraint is the quantity of encounters partitioned by minimum horizontal separation for both aircraft to aircraft and aircraft to airspace [5]. The other characteristics are provided as advisory to ensure that the test includes reasonable coverage of the various other factors that could influence the accuracy. The basic assumption is the data captured from the field and utilized for these scenarios is sufficient for the test.

The accuracy scenario will be delivered in an agreed upon format, consistent with the common message set definitions, and altered by one or all of the three methods discussed above (i.e. time compression, randomly adjusting, and cloning flights). However, in calculating the encounters and other characteristics of the scenario, various post processing of these altered raw HCS messages will be required, such as filling time gaps in track reports, interpolating track positions to synchronized time intervals, etc. Therefore, the generated accuracy scenario will include the raw messages as recorded from the HCS and only in determining the characteristics of the scenario will the data be modified for reasonableness.

3.1 Airspace Characteristics

As discussed above, the field data for the test scenarios has been collected from the ZME and ZID on May 26th and 27th, 1999. This data corresponds to the May 20, 1999 chart update cycle. The airspace characteristics of the scenarios are then those of either the ZME or ZID airspace. The characteristics of the airspace for each center come directly from the 5/20/99 adaptation, some reportable characteristics ACT-250 plans to summarize include the quantities of:

- Center Area
- Airports
- Sectors
- Airways
- Preferential Routes
- Special Use Airspaces
- APDIAs

3.2 Encounter Distributions

The objective of the following encounter metrics is to measure the quantity and geometry of these encounters in the accuracy scenario. An encounter is defined as an event where two aircraft or an aircraft and a special use airspace simultaneously violate vertical separation standards[1] and are separated less than 30 nautical miles horizontally. The 30 nautical mile threshold was chosen to capture encounter situations of sufficient distance to satisfy all the counts defined in *Lockheed Martin Air Traffic Management (LMATM) SIG Issue 166*, which includes counts of greater than 24 nautical miles minimum horizontal separation [5].

These encounters are determined by preprocessing the HCS track reports. The processing includes filtering the track aircraft positions for reasonableness by the ACT-250 software tool called RDTRACKS described in [10]. This requires design thresholds including definitions on what constitutes a reasonable position report and how much of a gap in time and space can be repaired with interpolation. The current settings in RDTRACKS will interpolate through a gap of 120 seconds or less of HCS track reports. If the gap is larger, the software essentially retains the gap making no assumptions for the unknown time interval and reinitializes by continuing the track processing after the track resumes. The software considers the track positions after the gap as a second segment of the flight. If URET CCLD presents alerts during the gap, they could be considered false alerts incorrectly. Therefore, this example requires some thought for the accuracy analysis of URET CCLD.

The software tool, called Track Conflict Probe (TCP), processes the track reports to determine if and when the aircraft to aircraft encounters take place. TCP Part 1 takes the filtered tracks from RDTRACKS interpolates them to consistent ten second intervals on the hour, described in detail in [1] and [10]. The next program, called AIR, determines if each processed track point is inside or outside an Automated Problem Detection Inhibited Area (APDIA), which is used later to exclude track points in evaluating encounters. TCP Part 2 actually performs the aircraft to aircraft track conflict analysis, described in detail in [10]. A separate tool, called SUAS_PEN, serves a similar function as TCP Part 2 for aircraft to airspace encounters. It models special use airspace (SUA) as polygon shapes and determines if and when aircraft to airspace encounters occur[2].

Briefly, TCP Part 2 compares all aircraft pairs for encounters and SUAS_PEN compares all aircraft and airspace pairs[3]. First, each pair is checked for time overlap. If time overlap exists in general, a gross filter is triggered that simply compares the maximum and minimum coordinates of both flights' tracks or the flights' tracks and airspace buffered boundary are within 3000 feet vertically and 35 nautical miles horizontally. If the aircraft pair passes the gross filter, all the individual aircraft pair's tracks not in an APDIA are compared and encounters of 30 nautical miles horizontally and standard separation vertically are recorded. If the pair, either aircraft to aircraft or aircraft to airspace, do pass the gross filter and do not have any encounters, their minimum separations are recorded in a separate database table.

There are several additional design considerations. If an encounter ends but resumes within five minutes from the end time of the previous one, the situation is considered one long encounter. If the encounter lasted for ten seconds or less, the encounter is excluded for obvious reasons. If an aircraft is in the cruise

[1] Standard vertical separation requires 1000 feet up to and including Flight Level (FL) 290 and 2000 feet above. In practice for our tools, if neither flight is on FL 290, the lower altitude of both flights is used for the rule. If one of the aircraft is on FL 290, the altitude above FL 290 requires 2000 feet separation and below requires only 1000 feet.

[2] ACT-250 plans to supply LMATM with a list of additional SUAs not in the 5/20/99 field adaptation required to induce additional encounters for the scenario.

[3] There are at most $\left[\frac{n(n-1)}{2}\right]$ (where n = number of aircraft in scenario) aircraft to aircraft pairs in a scenario. There are at most $[n * s]$ (where s = number of SUAs) aircraft to airspace pairs in the scenario.

phase of flight and is within 300 feet from its assigned altitude, it is assumed to be cruising at the assigned altitude. This may allow an aircraft pair to be separated by less than the standard vertical separation actually and not be considered an encounter, obviously only under these strict conditions. This exception is explained in [1], but in general attempts to model the NAS display threshold of 300 feet off the assigned altitude during cruise flight.

Another design consideration is the consequence of gaps in the post processed HCS track data during an encounter. The current rules will consider the start of the gap an end to the encounter. However, if the gap is less than five minutes, consistent with the combine conflict rule above, and the aircraft or airspace are separated less than the encounter distances (i.e. 30 nautical miles and vertical separation standard) after the gap ends, the entire duration is considered in conflict. These hopefully rare situations will be logged in a separate file to help address potential issues in the later conflict probe analysis using the scenario.
There are additional design considerations of only marginal interest for TCP Part 2 and SUAS_PEN programs. As defined in the *URET CCLD SSD* under certain conditions, missed alerts may be excluded if they occur within 5 minutes of a clearance (i.e. flight plan amendment or interim altitude clearance) [4]. However, they will still be counted as valid alerts if correctly predicted. Also if the DST does not predict the conflict at all, it may still be counted as a missed alert[4]. For these cases, the conflict cannot be excluded but may be simply flagged as a special case and this information could have value later in conflict prediction analysis by other future applications.

3.2.1 Aircraft to Aircraft Encounters

There are currently two types of aircraft to aircraft encounters being evaluated. The first is designed for current plan trajectories and requires both aircraft involved in the encounter to be in flight plan adherence[5] for 13 minutes prior to the start time of the conflict. The second is designed for trial plan trajectories and requires both aircraft involved in the encounter to be in flight plan adherence for 23 minutes prior to the start time of the conflict.

For checking the time in flight adherence for aircraft to aircraft encounters, there is an important distinction between conflict and encounter. Conflicts are violations of standard separation in both dimensions (i.e. 5 nautical miles horizontally and 1000 feet at or below Flight Level 290 and 2000 feet above in the vertical). The encounters are defined at the same standard vertical separation but with a larger horizontal threshold of 30 nautical miles. For encounters that include conflicts, the flight adherence is measured at the start of the conflict. Once again, this occurs when the aircraft pair first come within 5 nautical miles during the encounter. If an encounter does not include a conflict which means the minimum horizontal separation is greater than or equal to 5 nautical miles but less than 30 nautical miles, the time in flight adherence depends on the minimum horizontal separation calculated for the duration of the encounter. By using the upper limits in Table 3.2-1 and Table 3.2-2, which will be described in more detail in Section 3.2.1.1, the time in flight adherence is measured from the upper limit of the interval that the minimum horizontal separation falls. For example, an encounter that has a minimum horizontal separation of 8 nautical miles would use the time the aircraft pair just came below 10 nautical miles horizontally. This also works for conflicts, since an aircraft to aircraft encounter that has an actual conflict would have a minimum horizontal separation of less than 5 nautical miles. For both Table 3.2-1 and Table 3.2-2, the upper limit for the lowest interval is also 5 nautical miles and the start of the actual conflict.

Not all encounters actually cross one of the upper horizontal limits in Table 3.2-1 and Table 3.2-2 during the encounter. To be an encounter, an aircraft pair or aircraft and airspace must not only violate a horizontal separation threshold, but simultaneously violate a vertical separation threshold as well. Sometimes the vertical threshold is not violated until the aircraft is already within one of the Table 3.2-1 and Table 3.2-2's bins. For example, an aircraft pair could still have a minimum horizontal separation of 8 nautical miles like the previous example, however the start of the encounter was at 9 nautical miles when

[4] The FAA and LMATM are currently discussing the interpretation of this particular missed alert case, so the details are still subject to change.
[5] Flight plan adherence is described later in this paper in Section 3.5.

one of the aircraft leveled off at the others flight level. Therefore, adherence age would be calculated at either the start of the encounter, like this example, or when crossing one of the upper horizontal limits in Table 3.2-1 and Table 3.2-2 , whichever takes place last for the duration of the encounter.

There are several reasons for measuring the time in flight adherence from the reference times discussed above. The main reason is it ensures all actual conflicts (i.e. violations of separation at standard separations) are checked for flight plan adherence at the start of the conflict. Later in the accuracy testing of URET CCLD, these same conflicts can be used for measuring missed alerts and valid alerts. In general, missed alerts are counted when a conflict occurs, but the DST does not present an alert at all or within a parameter time of the start of the conflict. Valid alerts occur when the conflict occurs and the DST does present the alert in a timely manner.

The third event counted in the accuracy analysis is the false alert. In general, a false alert occurs when the DST presents an alert, but a corresponding conflict does not occur. For accuracy measurement of false alerts, LMATM is planning to use the predicted start time of the conflict as the reference time for flight plan adherence (see references [4] and [6]). In other words, a false alert may be excluded if the flight is not in adherence for 13 minutes before the predicted start time for current plans and 23 minutes for trial plans. At the time the accuracy scenario is generated, the encounters of aircraft pairs with minimum horizontal separations of 5 nautical miles and greater are generated without knowledge of the alert's predicted conflict start time. In the generation of the encounters, a conservative estimate for defining the flight plan adherence reference time is the time that the aircraft pair are separated by a parameter distance. As discussed previously, this parameter distance is variable corresponding to the particular upper limit of the interval in either Table 3.2-1 or Table 3.2-2 that the minimum horizontal separation falls.

3.2.1.1 Counts of Encounters Partitioned by Minimum Horizontal Separation Interval

One of the strict constraints for the accuracy scenarios is the minimum count of the encounters partitioned by the minimum horizontal separation intervals. These are taken directly out of *LMATM SIG 166* [5] and determined by statistical analysis in *LMATM SIG 001* [6]. ACT-250 altered the last interval's upper bound of infinity to a threshold of 30 nautical miles. The upper bound provides the TCP program with a horizontal separation threshold as well as satisfying LMATM's counts. Refer to Appendix A, Table A.1-1, for a sample count of these encounters.

The following Table 3.2-1 defines the intervals for aircraft to aircraft encounters of the current plan flights.

Table 3.2-1: Current Plan Aircraft to Aircraft Encounter Counts

Minimum Horizontal Separation (nm)	Total Number of Encounters Required
$0 \leq d < 5$	506
$5 \leq d < 10$	506
$10 \leq d < 15$	506
$15 \leq d < 23$	506
$23 \leq d < 30$	506

The following Table 3.2-2 defines the intervals for aircraft to aircraft encounters of the trial plan flights:

Table 3.2-2: Trial Plan Aircraft to Aircraft Encounter Counts

Minimum Horizontal Separation (nm)	Total Number of Encounters Required
$0 \leq d < 5$	506
$5 \leq d < 10$	506
$10 \leq d < 15$	506
$15 \leq d < 24$	506
$24 \leq d < 30$	506

3.2.1.2 Counts of Encounters Partitioned by Altitude Interval

A characteristic of the encounters is their frequency or counts as a function of altitude. The altitude of the encounter is evaluated by using the larger of the two aircraft's altitudes at the start of the encounter. Since the aircraft pair must be within standard vertical separation for the duration of the encounter, the start of the encounter is representative of the entire encounter situation. The intervals are in units of feet and start at zero and go to a maximum of 45,000 feet. Each interval's width is 1000 feet below 29,000 feet and 2000 feet above 29,000 feet, making 37 intervals in all.

3.2.1.3 Counts Partitioned by Encounter Angle and Vertical Phase of Flight

Two additional characteristics of an encounter's geometry are the encounter angle and vertical phase of flight during the encounter. With encounter angle being reported at 45 degree increments and with six possible vertical state combinations (i.e. individually cruise, climb, or descent) for the two aircraft, these two variables form 24 total combinations. Refer to Appendix A, Table A.1- 2, for a sample of the encounters partitioned by vertical phase of flight and encounter angle.

The encounter angle is calculated at the time of minimum horizontal separation by post processing the HCS track reports. The current approach is to use the average heading calculated from the three points starting with the time of minimum horizontal separation, 10 seconds before this time, and 10 seconds after this time. Therefore, the encounter angle is based on 20 to 30 seconds of track position reports for each involved aircraft. The encounter angle is calculated by taking the absolute value difference between the aircraft pair's average heading. Since the relative angle between the two headings is always formed by the smaller angle, the encounter angle is always between 0 and 180 degrees (see Figure 3.2-1).

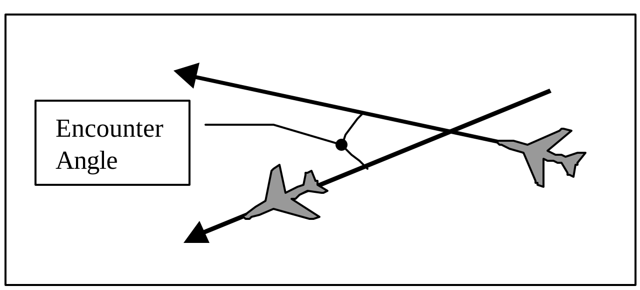

Figure 3.2-1: Example Encounter Angle

Individually for each aircraft involved in the encounter, there are currently two approaches ACT-250 is using to calculate the vertical phase of flight. The first approach is calculated by examining the transition rate in the vertical dimension between each post processed HCS track position during the full duration of the encounter and an additional window before the start and after the end of the encounter. The post processed HCS track positions are processed for reasonableness by the RDTRACKS tool and then interpolated to 10 second intervals synchronized to the hour by the TCP_P1 tool [10]. The vertical phase of flight algorithm calculates the vertical transition rate (i.e. altitude change in feet divided by time interval in seconds) and starts 10 seconds before (i.e. one position point) and 10 seconds after the end of the encounter. The maximum and minimum transition rates for this window of time are evaluated and used in the following heuristic[6]. The heuristic may be better visualized by reviewing the following Figure 3.2-2.

1. If less than 3 transition rates were calculated, assume an unknown vertical phase of flight.
2. If the minimum transition rate is above the transition rate threshold, evaluate as a climb.
3. Else-if the maximum transition rate is below the negative of the transition rate threshold, evaluate as a descent.
4. Else-if the maximum transition rate is above the transition rate threshold and the minimum transition rate is above the negative of the transition rate threshold, evaluate as a climb.
5. Else-if the maximum transition rate is below the transition rate threshold and the minimum transition rate is below the negative of the transition rate threshold, evaluate as a descent.
6. Else-if the maximum transition rate is above the transition rate threshold and the minimum transition rate is below the negative of the transition rate threshold, evaluate as an unknown vertical phase of flight (i.e. both descent and climb transitions during encounter window).
7. Else the aircraft is evaluated as in cruise vertical phase of flight.

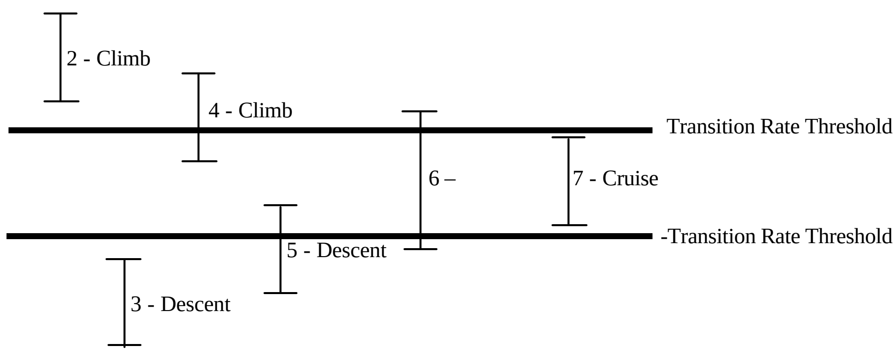

Figure 3.2-2: Vertical Phase of Flight Heuristic Logic

The second approach being considered for determining the vertical phase of flight for the encounter is a two step process. First, the altitude of the post processed HCS track positions (same 10 second interpolated points as described above) are smoothed. The details of the smoothing algorithm are still under development, but the current technique is to use weighted average centered at the current point. For example by employing a simple 3 point weighted average, if three consecutive altitudes read 31,000 feet, 31,300 feet, and 31,400 feet, the smoothed altitude of the middle track position would be 31,250 feet. Once the altitudes are smoothed, each consecutive set of track points are compared using the following heuristic:

1. If the absolute value difference between the current altitude and the next altitude is less than threshold number of feet[7], the point is evaluated as in cruise.
2. Else -if the next altitude is greater than the current altitude, the point is determined as climbing.
3. Else-if the next altitude is less than the current altitude, the point is determined as descending.

[6] The heuristic utilizes a parameter in determining the vertical phase of flight. This parameter called the transition rate threshold is currently set to 11.7 feet per second or 700 feet per minute.
[7] The current threshold used is 10 feet, however more experimentation will verify this value. For planning purposes, the threshold would be within 10 to 150 feet.

The vertical phase of flight flags are utilized by extracting the flags for a window of time before, at, and after the time of minimum horizontal separation during the encounter. Currently a threshold of 10 seconds is chosen around the minimum horizontal separation time. This translates to three of the post processed transition points. If all the flags for the extracted points are flagged as cruise, the encounter is labeled as cruise. If some are flagged as either descent-cruise or climb-cruise, the encounter is labeled as descent or climb respectively. However, if the extracted points have both descent and climb flags, the encounter is labeled as unknown, much like the first approach.

Both these approaches are currently being evaluated as viable techniques in determining the vertical phase of flight for the encounters. Only one technique will be used for the scenario generation process, the second approach is the current choice, since it is the more practical technique and can be used by other areas like flight adherence. The first approach was employed in the ACT-250 Conflict Prediction Study in 1998 [1] and is used to calculate the encounter phase of flight counts in Appendix A.1 (see Table A.1-2). A simplified version of the second approach was used in the ACT-250 Trajectory Accuracy Study in 1999 [10].

3.2.2 Aircraft to Airspace Encounters

There are two types of aircraft to airspace encounters that are evaluated for the accuracy scenarios, much like the aircraft to aircraft encounters. The current plan encounters require the aircraft to be in flight adherence for 13 minutes prior to the start of the conflict. Trial plan encounters require 23 minutes of flight adherence prior to the start of the conflict. As discussed in Section 3.2.1 for aircraft to aircraft encounters, the minimum horizontal separations and the Table 3.2-3 and Table 3.2-4 are used to determine the reference time in which flight plan adherence is calculated. The only difference is the aircraft to airspace encounters have different bounds for the minimum horizontal separation intervals. The most notable is the lowest interval that equals zero. A minimum horizontal separation of zero for aircraft to airspace encounters means the aircraft penetrated the buffered boundary of the airspace (inside or negative minimum separations are not calculated). Therefore, the upper bound for this interval would be the time the aircraft first penetrated the buffer boundary. This is analogous to the 5 nautical mile upper bound for aircraft to aircraft conflicts, namely it marks the start of the actual conflict and adherence would be measured from that time backward.

3.2.2.1 Counts of Encounters Partitioned by Minimum Horizontal Separation Interval

Much like the aircraft to aircraft encounters, the other strict constraint for the accuracy scenarios is the minimum count of the encounters of aircraft to airspace partitioned by minimum horizontal separation intervals. These are taken directly out of *LMATM SIG 166* [5] and determined by statistical analysis in *LMATM SIG 001* [6]. ACT-250 altered the last interval's upper bound of infinity to a threshold of 30 nautical miles. The upper bound provides the airspace penetration program (SUA_PEN) with a horizontal separation threshold as well as satisfying LMATM's counts. Appendix A.2, Table A.2- 1, presents a preliminary sample of counts using actual traffic data.

The following Table 3.2-3 defines the intervals for aircraft to airspace encounters of the current plan flights:

Table 3.2-3: Current Plan Aircraft to Airspace Encounter Counts

Minimum Horizontal Separation (nm)	Total Number of Encounters Required
$0 = d$	506
$0 < d < 7$	506
$7 \leq d < 9$	506
$9 \leq d < 11$	506
$11 \leq d < 16$	506
$16 \leq d < 30$	506

The following Table 3.2-4 defines the intervals for aircraft to airspace encounters of the trial plan flights:

Table 3.2-4: Trial Plan Aircraft to Airspace Encounter Counts

Minimum Horizontal Separation (nm)	Total Number of Encounters Required
0 = d	506
0 < d < 8	506
8 ≤ d < 11	506
11 ≤ d < 13	506
13 ≤ d < 19	506
19≤ d < 30	506

3.2.2.2 Counts of Encounters Partitioned by Altitude Interval

A characteristic of the encounters is their frequency or counts as a function of altitude. The altitude of the encounter is evaluated by using the aircraft's altitude at the start of the encounter with the airspace. Since the aircraft must be within standard vertical separation of the airspace for the duration of the encounter, the start of the encounter is representative of the entire encounter situation. The intervals are in units of feet and start at zero and go to a maximum of 45,000 feet. Each interval's width is 1000 feet below 29,000 feet and 2000 feet above 29,000 feet, making 37 intervals in all.

3.2.2.3 Counts Partitioned by Encounter Angle and Vertical Phase of Flight

Two additional characteristics of an encounter's geometry are the encounter angle and vertical phase of flight during the encounter. With encounter angle being reported at 30 degree increments up to a maximum of 90 degrees and with three possible vertical states (i.e. cruise, climb, or descent), these two variables form 9 total combinations.

The encounter angle for an aircraft and airspace is calculated only if the aircraft penetrates the buffered boundary of the airspace. Therefore, all 30 nautical mile aircraft to airspace encounters may not have an encounter angle. When they do penetrate the boundary, the encounter angle is determined by first determining the line segment between the point first inside the boundary and the previous point outside. Since the encounter is using post-processed HCS track reports, the positions are 10 seconds apart. The encounter angle is determined by calculating the cosine angle, which is formed by the scalar dot product of the track based line segment and the penetrated side of the buffered boundary. Since we are only interested in the relative angle between zero and 90 degrees, the inverse cosine function is used to transform the cosine result into an angle in degrees where the cosine result is an absolute value of the dot product divided by the product of each vector's magnitude. For example, the absolute value of the cosine result will be a number 0 to 1 and will evaluate as an angle between 90 and zero degrees using the inverse cosine function.

There are two types of encounter angles: one that occurs when the aircraft penetrates through the side of the airspace and the other is when the aircraft penetrates through the top or bottom of the airspace. The actual calculation of the encounter angle is the same for either type, however the type will be flagged for later processing.

Currently, there are two design considerations when evaluating the encounter angle. In the previously described approach, it was assumed that a track point existed prior to entry into the SUA buffered boundary, so if it did not, an encounter angle will not be calculated. This can occur under two cases:

1. The aircraft's track positions starts inside the SUA and there is no previous track data at all.
2. If the previous track point before penetration is beyond 10 seconds in time, a track time gap occurred during the encounter and penetration. Since we are using post-processed HCS track reports, this only can occur if the gap is greater than two minutes. If the gap was greater than five minutes, they would be considered two encounters and the last encounter would have started inside the SUA.

For the second design consideration, if a particular aircraft has multiple penetrations (i.e. entrances and exits) for the same encounter with a SUA buffered boundary, the encounter angle will only be calculated on the first penetration.

The vertical phase of flight of the aircraft during the encounter with the airspace can be calculated using either of the approaches described for the aircraft to aircraft encounters (see Section 3.2.1.3). For the aircraft-airspace encounters, the vertical phase of flight for the single aircraft involved in the encounter is one of three cases, climbing, descending, or cruising.

3.3 Air Traffic Distributions

Air traffic distributions describe the general traffic levels of the scenario and may or may not be directly related to the encounters produced by the time selection algorithms. The traffic distributions are typically a function of the field data captured for the accuracy testing. The objective of these statistics is to describe the general traffic conditions of the accuracy scenario.

3.3.1 Air Traffic Density

Air traffic density describes the mean and variance of the minimum horizontal separations per altitude per unit of time (e.g. one hour) of the recorded aircraft to aircraft encounters. It is a general density description of the scenario and is proportional to the number of encounters induced by the time selection algorithm. From the recorded encounters defined in Section 3.2.1, it is estimated by measuring the average and standard deviation minimum horizontal separation per altitude interval (i.e. 1000 feet intervals from ground to FL 280 and 2000 feet intervals from FL 290 to FL 450) per hour. Refer to Appendix B.1 for a sample of air traffic density information.

3.3.2 Active Flights

The active flights are the number of aircraft flights currently under the particular center's control and thus potential candidates for modeling by the URET or URET CCLD.

3.3.2.1 Total Flights Count per Scenario

The total flights in the scenario are the number of active flights which have both a HCS flight plan and track positional data and have been successfully post processed for reasonableness (see Section 3.2).

3.3.2.2 Rate of Flights per Minute

The rate flights are the number of active flights per minute that have a HCS flight plan, HCS track data, and have been post processed for reasonableness. This rate is estimated by the average, standard deviation, maximum, and minimum number of flights per minute during the scenario. Refer to Appendix B.2 for example based on preliminary traffic data.

3.3.3 Flight Type Distribution & Sector Penetration

Another set of statistics describing the air traffic situation is the flight type distribution and the duration and quantity of sector penetrations of the scenario.

Each aircraft flight is defined as one of four flight types, including overflight, arrival, departure, or internal. An overflight has both origin and destination airports outside the center of study. An arrival has only the destination airport inside the center of study. A departure has only the origin airport in the center of study. Finally, an internal flight has both origin and destination airports inside the center of study.

The average number of sectors penetrated, average time within each sector, and the average time within the center are all calculated as a function of the flight type. Table 3.3-1 below, even though absent of data, provides a good representation of the various combinations of statistics. Refer to Appendix B.3 for a sample of flight type and sector penetration statistics on actual traffic data.

Table 3.3-1: Flight Type and Sector Penetration Statistics[8]

	Flight Type				
	Arrivals	Departures	Internals	Overflights	All Flight Types
Average number of sectors penetrated					
Average time in Center (minutes)					
Average time in sector (minutes)					
Percentage of flights per flight type					

3.3.4 Aircraft Ground Speed per Altitude/Flight Level

Ground speed is calculated for each track position report by the HCS and supplied in the HCS track messages. The magnitude of the ground speed is captured per flight and the average ground speed per altitude interval (defined in Section 3.3.1) is calculated. Refer to Appendix B.4 for a sample set of ground speed information.

3.3.5 Ratio of Flights in APD Zone to Center Boundary

The ratio of flights with track in APD zone to center boundary is measured by counting the number of post processed HCS track reports in the center boundary compared to the number outside per unit of time (e.g. one minute).

3.3.6 Interim Altitude Messages per Flight

Interim altitude messages per flight are extracted from the field data. Point statistics such as average, standard deviation, maximum, and minimum are generated for these counts.

3.3.7 Amendment Messages per Flight

Amendment messages per flight are extracted from the field data. Point statistics such as average, standard deviation, maximum, and minimum are generated for these counts.

[8] This table is modeled after Table 7 on page 107 in *URET CCLD System Segment Specification* [7].

3.3.8 Air Traffic Maneuvers

Measuring the air traffic maneuvers such as turns, ascents, and descents quantifies the level of change in the flights themselves. However, the source for determining whether a flight is in these maneuvers is dependent on the HCS track reports which does include considerable noise. Therefore, the current approach is to determine the phase of flight and thus these maneuvers by first post processing and smoothing the HCS track positions. The post processing of the HCS tracks is a check for reasonableness and is described in Section 3.2.1.3 [10]. Next, a smoothing algorithm is applied to the positions based on a weighted average approach. The details of the smoothing are still being evaluated. One example is a simple three point weighted average such that the previous track point counts for one, the current track point counts for two, and the next track point counts for one again. Next, the phase of flight is determined based on these smoothed positions.

3.3.8.1 Turns per Altitude/Flight Level

Each post processed HCS track position is determined to be either turning or on a straight portion of flight using the smoothed values of the track. The details for calculating a turn based on track data is described in [10]. The basic concept is to use the positions before and after the current track point and calculate the angle between the line segments that join these track points. If the angle is beyond a certain value, the track is considered in a turn. Depending on whether the angle falls to the right or left of the aircraft's path, the turn is labeled accordingly.

3.3.8.2 Ascents & Descents per Altitude/Flight Level

Much like the turning in the horizontal dimension, the vertical transitions are also calculated based on the post processed and smoothed HCS track data. For the vertical, the calculation is simply the difference between successive altitude reports divided by the interval time, where the details are also described in [10].

3.4 Aircraft Distributions

The aircraft distributions describe the characteristics of the aircraft and airlines in the scenario. They are directly based on the sample field data captured for the scenario generation process. The larger the sample of data collected from the field the more broadly representative the scenario. The aircraft types, models, equipage, and airlines all attempt to describe characteristics of the scenario data and highlight the complexity of the source field data.

3.4.1 Types

The aircraft types define categories for the aircraft models found in the scenario. All the aircraft will be categorized into one of the following three types: (1) Jet, (2) Turboprop, and (3) Piston. Refer to Appendix C.1 for a sample count of the aircraft type categories.

3.4.2 Models

The model of the aircraft will be identified from the HCS flight plan message (e.g. B737, B727, or DC9). The frequency of the model types will then be calculated for each scenario. Refer to Appendix C.2 for a sample of aircraft model types.

3.4.3 Equipage

The type of navigational capability or equipage of each aircraft will also be captured from the HCS flight plans. The equipage is delineated as navigational equipped or not. Currently, the flight plan codes of C, R, I, W, G, E, and F refer to navigational equipped aircraft and the remaining codes refer to non- navigational. The number of flights with navigational and non-navigational capability will be quantified for each scenario. Refer to Appendix C.3 for sample of equipage frequencies.

3.4.4 Airlines

Each airline has its own pilot procedures and thus may influence the performance of the conflict probe tool predicting the flight's path. In each HCS flight plan message, the airline is specified by the aircraft identification code or ACID. For example, AAL1027 specifies that the aircraft is being flown by an American Airlines pilot following the AAL procedures. The frequency of the airline types will be quantified for each scenario. Refer to Appendix C.4 for a sample list of the airlines present in the source data.

3.5 Adherence to Air Traffic Control Clearance

The adherence to the current Air Traffic Control (ATC) clearance is defined as the status of whether the aircraft is following its known clearance at each instance of time during its flight. It is determined by measuring the lateral and vertical deviations between the cleared route of flight to the current track position. If this lateral or vertical deviation is beyond a threshold, the particular track point and flight at that point in time is considered to not be in adherence to its current ATC clearance. Therefore, each post processed HCS track point should have two new attributes or adherence status flags associated with it, one for vertical and the other for lateral. In other words, the status would simply be a flag with a zero for in adherence and one for out[9]. The third adherence attribute for each track is the adherence age, defined as the amount of time from the current time until the last track was out of adherence. These three adherence attributes have applications in counting the encounters discussed in Sections 3.2.1 and 3.2.2.

One design consideration of the adherence age is its value at the first track point or any track point associated with a flight plan amendment (i.e. next track report after amendment given). If the first post processed HCS track point or any track point associated with a flight plan amendment is both laterally and vertically in adherence, the adherence age is assumed infinite. For the next track report and beyond, it stays at an infinite age until it goes out of adherence and at that time the age is reset to zero. In other words, at the start of the flight or after a new flight plan amendment the aircraft is assumed to have been in adherence infinitely. For practical purposes, the term infinite simply means beyond all planning horizon values. If a flight is out of adherence for several track reports, the adherence age will be reset to zero until it returns to in adherence. When this example flight, returns to both vertical and lateral in adherence status, the current adherence age will still be zero but will start to increase as the later tracks remain in adherence.

Another design consideration is the adherence age following a large gap in the post-processed track reports (see reference [10] Section 2.4.3 for details on how that could happen). The assumption of the adherence age value for track reports returning from a large gap in track data during the flight is zero, by default.

3.5.1 Lateral Flight Plan Adherence

The first measure to test for flight adherence is the lateral deviation of a point and a segment along the route. The algorithm used is basically an adaptation of the HCS OUTLAT flag [2][3] and LMATM's deviation from route algorithm described in [8]. Each track point will be associated to a route segment (i.e. currently the expanded route by the URET DU Prototype for the same adaptation chart cycle of the accuracy scenario). Referring to Figure 3.5-1, the vector U is drawn from point 1 on the route to the track point t. The vector V is drawn from point 1 on the route to the next fix, called point 2. The vector W is drawn from point 2 to the track point t. The projected distance from the track point t to the vector V is the lateral deviation for most cases, except when the projection falls beyond the route segment. Under this exception, the minimum distance between the segment ends and the track (i.e. |U| or |W|) is used as the lateral deviation.

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[9] ACT-250 can supply the adherence status flags in a file for the post processed HCS track reports for the accuracy scenarios. These track reports may not be time coincident to the tracks in the generated accuracy scenario due to the post processing interpolation but can be compared with minimal effort.

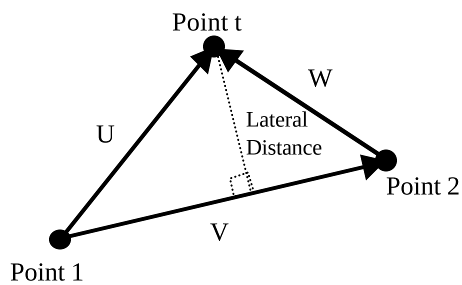

Figure 3.5-1: Vector Diagram of Route Segment and Track Point

The algorithm is as follows:

Let,

$$u_1 = x_t - x_1 \text{ and } u_2 = y_t - y_1$$
$$v_1 = x_2 - x_1 \text{ and } v_2 = y_2 - y_1 \qquad \textbf{Eq 3-1}$$
$$w_1 = x_t - x_2 \text{ and } w_2 = y_t - y_2$$

where the x and y values are the stereographic coordinates consistent with the HCS, and

$$|U|^2 = u_1^2 + u_2^2$$
$$|V|^2 = v_1^2 + v_2^2 \qquad \textbf{Eq 3-2}$$
$$|W|^2 = w_1^2 + w_2^2$$

The variables in Eq. 3-2 are the squared magnitudes of the vectors U, V, and W in Figure 3.5-1.

The scalar dot product is used to determine if the projection is on the segment. If the dot product divided by the squared magnitude of vector V (i.e. $|V|^2$) is between zero and one inclusive, the projection is on the route segment. Therefore, the quantity k in Equation 3-3 is used to decide on whether to use Equation 3-4 for the lateral deviation or one of the vector lengths |U| or |V|. The Equation 3-4 is the lateral distance between the track point t projected onto the route segment vector V. It is defined by the vector cross product divided by the length of the vector V.

$$k = \frac{(U \bullet V)}{|V|^2} = \frac{(u_1 * v_1) + (u_2 * v_2)}{(v_1^2 + v_2^2)} \qquad \textbf{Eq 3-3}$$

$$\text{lateral deviation if on the segment} = \frac{(U \times V)}{|V|} = \frac{(u_1 * v_2) - (u_2 * v_1)}{\sqrt{(v_1^2 + v_2^2)}} \qquad \textbf{Eq 3-4}$$

For each post processed track point, the lateral deviation is calculated for each route segment. The minimum lateral deviation after looping through all the segments is defined as the lateral deviation for that track point. This minimum lateral deviation marks the route segment that the track is associated to. Each route segment is preprocessed and each of the segment's endpoints is evaluated as being a turn fix. A turn fix is a route endpoint that marks the common point between two segments that have an angle between them that is greater than threshold variable in degrees, currently set at 30 [3]. If the track point is within a threshold of distance (currently set at 15 nautical miles) to the turn fix, the track point is considered in a turn [3].

For the OUTLAT thresholds in the HCS, the lateral deviation is compared to the following Table 3.5-1 [2]. If the lateral deviation is within tabulated thresholds, the aircraft is considered in lateral adherence to the flight plan. Unlike the HCS, the associated altitude used in referring to Table 3.5-1 thresholds is the reported post processed altitude in the track report (the HCS uses the assigned altitude [3]).

Table 3.5-1: Lateral Adherence Thresholds [2]

Associated Altitude (100's of feet)	Enroute (nm)	Turn (nm)
$H \leq 100$	4	8
$100 < H \leq 180$	6	10
$180 < H \leq 330$	8	12
$330 < H$	10	14

The thresholds for distance to the turn fix (i.e. 15 nm), angle of the turn fix (i.e. 30 degrees), and the lateral distances in Table 3.5-1 are taken from NAS documentation of nominal values used in the HCS for similar functionality [2] [3]. However, the threshold values supplied here are provided as a starting point and are subject to change depending on the results of an ongoing analysis. It is expected that the values in Table 3.5-1 and the distance to turn fix could be larger, and the angle of the turn fix could be smaller.[10]

One other design consideration in defining if an aircraft is adhering laterally to the flight plan is the particular navigation equipment being utilized by the flight. URET DU uses expanded distances for non-navigational equipped aircraft (see Section 3.4.3) when monitoring the flights for rebuilding its trajectory predictions. In this same theme, the lateral adherence thresholds in Table 3.5-1 could be expanded for these flights. The ongoing analysis will determine if this is necessary for lateral flight plan adherence. The result would be two versions of Table 3.5-1 with one for navigational equipped flights and another expanded version for non-navigation equipped.

3.5.2 Vertical Flight Plan Adherence

The vertical adherence is calculated by comparing the current track position altitude to the assigned altitude for tracks not in vertical maneuvers (by default tracks in vertical maneuvers are always in adherence). If the absolute difference between the associated altitude and the track position altitude is below 300 feet for tracks below Flight Level 290, it is considered in adherence vertically. If the same altitude difference is within 500 feet for tracks at or above Flight Level 290, it is also considered in adherence vertically [4].

3.6 Interfacility Traffic Flow

Interfacility messages are proportional to the traffic between facilities. For the accuracy scenarios, the center scenario is the Memphis ARTCC (ZME) and the interfacility center is the Indianapolis Center (ZID). The important traffic data for measuring interfacility message loading for these scenarios is the

[10] The results of the ongoing analysis to define exact thresholds for lateral adherence will be provided to the distribution list of this paper when the study is completed.

traffic data between these two centers. The rate of flights leaving and arriving into the ZME facility from ZID represents the interfacility communication for the two center accuracy run. Listed in Table 3.6-1, there are six potential input and output sources of flights into and out of the ZME facility. This metric will provide point statistics such as the average and standard deviation of the number of flights in each category per unit time (e.g. 1 minute) calculated over the duration of each scenario. In Table 3.6-1, the entries with the marked by the asterisk are the traffic between the ZME and ZID facilities. The other entries list the traffic either internal to ZME or entering and leaving from other adjacent facilities.

Table 3.6-1: Traffic Sources in the Scenario

Input Flights Into ZME	Output Flights Out of ZME
Arriving from ZID (overflights, arrivals)*	Arrivals to ZME to airport (internals, arrivals)
Departing from ZME (departures, internals)	Departing to ZID (departures, overflights)*
Arriving from other centers (overflights, arrivals)	Departing to other centers (departures, overflights)

3.7 Deviations in Weather Forecasts

The scenarios are dependent on the weather recorded for the same day and time of the traffic recording. This weather is recorded as RUC-211 and geographically filtered for URET and as RUC-236 for URET CCLD. Two minor analyses will be performed to report the general weather profile of the accuracy scenarios and their influence on the conflict probe's performance.

3.7.1 Range of Deviations in Weather Forecasts

The weather files will be reviewed sequentially in time between reporting points to quantify point statistics, such as the average, median, and standard deviation of the change in wind direction, wind speed, and temperature. These results will be compared to the Design Workload requirements of at most 50% of the center area's forecast winds to vary 29 degrees in wind direction, 19 knots in wind speed, and 4 degrees Centigrade [2]. As an approximation, only the one hour forecast files will be analyzed for these statistics. For example, the 1000 hour to 1100 hour weather forecast file is compared to the 1100 hour to 1200 hour weather forecast file. This analysis will show the change in weather between hourly forecasts.

3.7.2 Time Adjustment Influence on Trajectory Accuracy of URET Daily Use

The methods employed in the ACT-250 Trajectory Accuracy Study in 1999 [10] will be employed under a nominal scenario (i.e. no time adjustment) and compared to the accuracy scenario with time adjustment. The trajectory accuracy in the horizontal and vertical dimensions as a function of look ahead time will be used on URET Daily Use to verify that the performance does not decline significantly by the increased loading and or time shifting of the flight data. The time shifting does move aircraft in time and therefore would cause the trajectory modeling functions to use different weather forecast data for these flights. This analysis will simply provide insight into the magnitudes of these error sources. The process of refreshing the specification through running URET DU with the accuracy scenarios is the main method of reconciling these errors.

3.8 Vertical Modeling Accuracy

To measure the altitude modeling errors of URET DU and determine the refreshed requirement quantities for CIA873 and CIA874 in the SSS [7][11], the same vertical modeling accuracy is measured as described in the trajectory accuracy techniques described in reference [10]. The process includes post processing the HCS track reports for reasonableness, time synchronizing these track reports by interpolation, and performing the same time synchronizing and interpolation to the output trajectory predictions produced by URET DU using the generated accuracy scenario(s). The time coincident vertical track to trajectory deviations are calculated using the sampling techniques described in reference [10] and then post processed further as follows:

1) Parse out any flights with block altitudes, delays, and holds during its flight.
2) For each look ahead window, the maximum absolute vertical track to trajectory deviation is calculated with the following parameters as defined in Section 2.5.1.1 in reference [10]:
   a) TRAJ_SAMPLE_TIME = 30 seconds
   b) TRAJ_DELTA_TIME = 36 seconds
   c) TRAJ_LOOKAHEAD_WIN = 780 seconds (13 minutes, same as current planning horizon)
   d) TRAJ_LOOKAHEAD_TIME = 10 seconds
3) The look ahead window will also be truncated before the TRAJ_LOOKAHEAD_WIN if one of the following events take place first:
   a) The end of the post-processed track reports are reached along the look ahead window. (Note: HCS track reports are discarded in the post processing at the end of the flight when the aircraft has been handed off to a non-equipped CP ARTCC.)
   b) A post-processed track report is determined to be out of vertical adherence (see Section 3.5.2) along the look ahead window.
   c) A HCS clearance is given during the look ahead window.
   d) A large gap (see discussion of RDTRACKS in Section 3.2) in the post-process track reports occurs during the look ahead window.
4) For each look ahead window, the maximum absolute vertical track to trajectory deviation is applied to CIA873 if all the tracks along the look ahead meet the following conditions and are applied to CIA874 otherwise:
   a) If all the tracks in the look ahead window are level,
   b) within 500 feet of the assigned altitude,
   c) and if the beginning of the flight's tracks do not start on the assigned altitude, they must also be between an adapted time (i.e. 5 minutes) after the start of the level flight phase is reached and an adapted time (i.e. 5 minutes) before the end of level flight phase.[12]
5) Finally, the quantities for all the flight's sampled the look ahead windows (synonymous with current planning horizons) applied in Step 4 above for CIA873 and CIA874 are calculated as follows:
   a) Nl = number of look ahead windows applied to CIA873 (level phase of flight)
   b) Nt = number of look ahead windows applied to CIA874 (non-level phase of flight)
   c) Cl = number of look ahead windows applied to CIA873 that had maximum absolute vertical deviations greater than 500 feet
   d) Ct = number of look ahead windows applied to CIA874 that had maximum absolute vertical deviation greater than 1500 feet (this value may be adapted in specification refresh)

[11]CIA873 and CIA874 are referred to as DD3671 and DD3672 in reference [4], respectively.

[12] If a flight's tracks actually start on the assigned altitude and are level, the requirement of having an adapted time of track reports after reaching level flight is relaxed. This prevents the need for a flight starting on the assigned altitude in the scenario to require 5 minutes of the level track reports to be associated to CIA874 irregardless of the phase of flight.

Acronyms

ACID	-	Aircraft Identification
ACT	-	FAA Designator for the William J. Hughes Technical Center
AOS	-	FAA Designator for Operational Support
ARTCC	-	Air Route Traffic Control Center
CPA	-	Closest Point of Approach (functionally equivalent to minimum horizontal separation)
CP	-	Conflict Probe
DST	-	Decision Support Tool
FAA	-	Federal Aviation Administration
FL	-	Flight Level
HCS	-	Host Computer System
IFR	-	Instrument Flight Rules
LMATM	-	LockHeed Martin Air Traffic Managment
LM	-	LockHeed Martin
nm	-	nautical mile(s)
NWS	-	National Weather Service
RNAV	-	Area Navigation Equipped
SAR	-	System Analysis Recording
SSD	-	System Specification Document (written by FAA)
SSS	-	System Segment Specification (written by LM)
SUA	-	Special Use Airspace
SUT	-	System Under Test
TCP	-	Track Conflict Probe
URET	-	User Request Evaluation Tool
XYZT	-	Four Dimensions of Space and Time
ZID	-	Indianapolis ARTCC
ZME	-	Memphis ARTCC

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Appendix A: Encounter Distributions for Preliminary Sample

The purpose of this appendix is to provide the reader with a preliminary view of potential characteristics of the accuracy scenarios and give additional insights in how the characteristics will be calculated. The tables and figures from Appendix A represent sample data from a five hour modestly time adjusted scenario. Specifically, this 5 hour of traffic data was compressed by 10 percent and randomly shifted using a normal distribution with a zero mean and standard deviation of 300 seconds. The source of the traffic data is from ZME collected on May 26, 1999.

The aircraft to aircraft encounter counts and other statistics are not checked for flight plan adherence, since the tools for measuring adherence are still under development. Therefore, the total scenario encounter counts reported in Appendix A will be higher than the actual accuracy scenarios.

ACT-250 does caution the reader that the following data is presented using untested versions of our software tools, so may contain some inaccuracies. Even under this assumption, the preliminary data does provide an adequate preview of what should be expected in the final scenarios.

A.1.   Aircraft to Aircraft Encounter Statistics

From the preliminary sample scenario, the Table A.1- 1 lists the total encounters per minimum horizontal separation interval as listed in Section 3.2.1.1. It is important to remember that these values are not considering flight plan adherence at this time.

Table A.1- 1: Total Encounter Counts From 5 hour Sample

Minimum Horizontal Separation (nm)	Total Number of Encounters
$0 \le d < 5$	200
$5 \le d < 10$	198
$10 \le d < 15$	280
$15 \le d < 23$	527
$23 \le d < 30$	486
Total	1691

The following Table A.1- 2 lists the encounter counts partitioned by phase of flight and encounter angles.

Table A.1- 2: Encounter Counts by Phase of Flight and Encounter Angles

Vertical Phase Of Flight	Encounter Angles (degrees) [0, 45)	[45, 90)	[90, 135)	[135, 180]	Column-Totals
Cruise-Cruise	81	110	69	37	297
Descend-Descend	60	24	11	13	108
Climb-Climb	40	11	5	11	67
Unknown	15	0	2	1	18
Cruise-Climb	139	91	88	146	464
Cruise-Descend	182	122	103	156	563
Climb-Descend	52	20	29	73	174
Row-Totals	569	378	307	437	1691

A.2. Aircraft to Airspace Encounter Statistics

From the preliminary sample scenario, the following Table A.2- 1 lists the counts of aircraft to airspace encounters by minimum horizontal separations as described in Section 3.2.2. The Table A.2- 1 presents encounters with SUAs that were set as active for the entire scenario run (no check for time overlap), using the same 5 hour sample scenario used in Section A.1.

Table A.2- 1: Total Aircraft to Airspace Encounters

Minimum Horizontal Separation (nm)	Total Number of Encounters
$0 = d$	1214
$0 < d < 7$	509
$7 \leq d < 9$	133
$9 \leq d < 11$	150
$11 \leq d < 16$	447
$16 \leq d < 30$	1268
Total	3721

Appendix B: Air Traffic Distributions for Preliminary Sample

The purpose of this appendix is to provide the reader with a preliminary view of potential characteristics of the accuracy scenarios and give additional insights in how the characteristics will be calculated. The tables and figures from Appendix B represent sample data from a five hour modestly time adjusted scenario. Specifically, this 5 hour of traffic data was compressed by 10 percent and randomly shifted using a normal distribution with a zero mean and standard deviation of 300 seconds. The source of the traffic data is from ZME collected on May 26, 1999. A 10 hour sample of traffic data from the same source, which was not time shifted, was also used for the flight type and sector penetration statistics in Section B.3.

The Section B.1 presents statistics on the air traffic density of flights in 30 nautical mile aircraft to aircraft encounters as defined in Section 3.2 without checking for flight plan adherence. Section B.2 presents statistics on the rate of flights that are active and candidates for DST modeling on a per minute basis. Section B.3 presents information on the flight type and sector penetrations of the sampled flights. The Section B.4 presents statistics on the average ground speed per altitude interval.

ACT-250 does caution the reader that the following data is presented using untested versions of our software tools, so may contain some inaccuracies. Even under this assumption, the preliminary data does provide an adequate preview of what should be expected in the final scenarios.

B.1. Air Traffic Density

Table B.1- 1 quantifies the encounter's average and standard deviation of the minimum horizontal separations partitioned per altitude interval per hour. Part 1 presents statistics totaled for all hours, and Part 2 to 6 presents statistics for each hour 1 to 5.

Table B.1- 1: Density of the Aircraft to Aircraft Encounters (Part 1 for all hours)

Total Count for 5 hours	Avg Hourly Count	Mean per Hour	Std Dev. per Hour	Lower Alt.	Upper Alt.
0	0	0	0	0	1000
0	0	0	0	1000	2000
2	0.4	5.67	0	2000	3000
9	1.8	11.39	3.72	3000	4000
13	2.6	8.59	4.89	4000	5000
25	5	15.54	5.95	5000	6000
27	5.4	18.05	6.69	6000	7000
23	4.6	20.39	7.18	7000	8000
29	5.8	14.74	7.18	8000	9000
7	1.4	11.9	5.3	9000	10000
17	3.4	12.89	7.63	10000	11000
25	5	14.95	8.42	11000	12000
14	2.8	11.55	5.58	12000	13000
16	3.2	12.48	5.08	13000	14000
13	2.6	11.87	3.24	14000	15000
36	7.2	18.17	6.62	15000	16000
28	5.6	17.74	6.45	16000	17000
30	6	17.23	5.08	17000	18000
42	8.4	15.86	4.3	18000	19000
19	3.8	15.48	5.04	19000	20000
21	4.2	17.82	8.28	20000	21000
19	3.8	19.32	5.41	21000	22000
19	3.8	16.91	3.97	22000	23000
22	4.4	21.02	7.25	23000	24000
22	4.4	12.49	5.35	24000	25000
27	5.4	13.22	5.32	25000	26000
37	7.4	14.15	6.09	26000	27000
85	17	18.46	7.68	27000	28000
65	13	19.72	7.09	28000	29000
289	57.8	15.47	8.06	29000	31000
272	54.4	14.98	8.15	31000	33000
256	51.2	16.88	8.97	33000	35000
110	22	16.09	8.79	35000	37000
40	8	12.27	6.01	37000	39000
26	5.2	16.41	7.99	39000	41000
5	1	6.05	1.28	41000	43000
1	0.2	2.85	0	43000	45000
1691	9.14	13.75	5.51		

Table B.1- 2: Density of the Aircraft to Aircraft Encounters (Part 2 for hour 1)

Hour	Count	Mean	Std Dev.	Lower Alt.	Upper Alt.
1	0			0	1000
1	0			1000	2000
1	0			2000	3000
1	0			3000	4000
1	0			4000	5000
1	0			5000	6000
1	5	21.90	7.84	6000	7000
1	3	17.68	6.92	7000	8000
1	3	11.91	8.53	8000	9000
1	2	17.22	12.35	9000	10000
1	2	14.07	11.25	10000	11000
1	6	18.96	6.15	11000	12000
1	1	7.08	0.00	12000	13000
1	5	16.67	5.85	13000	14000
1	0			14000	15000
1	5	18.46	7.50	15000	16000
1	4	23.10	3.18	16000	17000
1	6	16.02	8.53	17000	18000
1	1	16.81	0.00	18000	19000
1	1	27.63	0.00	19000	20000
1	2	13.96	15.74	20000	21000
1	1	19.91	0.00	21000	22000
1	2	12.23	1.45	22000	23000
1	1	27.44	0.00	23000	24000
1	0			24000	25000
1	5	14.62	6.64	25000	26000
1	0			26000	27000
1	4	24.44	4.54	27000	28000
1	2	25.23	4.79	28000	29000
1	13	15.52	8.17	29000	31000
1	9	14.23	8.97	31000	33000
1	23	15.71	8.48	33000	35000
1	9	16.48	10.67	35000	37000
1	2	17.66	6.42	37000	39000
1	2	20.72	0.20	39000	41000
1	0			41000	43000
1	0			43000	45000

Table B.1- 3: Density of the Aircraft to Aircraft Encounters (Part 3 for hour 2)

Hour	Count	Mean	Std Dev.	Lower Alt.	Upper Alt.
2	0			0	1000
2	0			1000	2000
2	1	11.85	0.00	2000	3000
2	1	7.92	0.00	3000	4000
2	6	19.61	5.73	4000	5000
2	6	19.05	5.60	5000	6000
2	3	20.49	9.22	6000	7000
2	12	15.93	8.26	7000	8000
2	19	18.71	8.06	8000	9000
2	1	13.81	0.00	9000	10000
2	4	18.86	9.14	10000	11000
2	7	12.86	8.75	11000	12000
2	5	17.50	6.47	12000	13000
2	3	16.26	6.79	13000	14000
2	7	18.04	7.28	14000	15000
2	8	16.98	8.67	15000	16000
2	6	19.30	4.24	16000	17000
2	8	14.46	10.21	17000	18000
2	18	21.63	7.16	18000	19000
2	8	18.99	9.24	19000	20000
2	9	20.29	7.43	20000	21000
2	6	18.96	9.29	21000	22000
2	7	23.43	3.57	22000	23000
2	5	18.38	9.44	23000	24000
2	5	20.59	5.36	24000	25000
2	6	22.81	4.54	25000	26000
2	7	18.00	9.80	26000	27000
2	16	19.80	9.29	27000	28000
2	8	19.43	7.72	28000	29000
2	43	18.10	7.07	29000	31000
2	63	16.38	8.23	31000	33000
2	60	17.79	8.26	33000	35000
2	35	19.70	6.60	35000	37000
2	10	17.08	7.91	37000	39000
2	5	18.18	11.03	39000	41000
2	3	12.33	6.42	41000	43000
2	0			43000	45000

Table B.1- 4: Density of the Aircraft to Aircraft Encounters (Part 4 for hour 3)

Hour	Count	Mean	Std Dev.	Lower Alt.	Upper Alt.
3	0			0	1000
3	0			1000	2000
3	1	16.49	0.00	2000	3000
3	3	13.63	11.36	3000	4000
3	2	8.68	8.92	4000	5000
3	3	20.08	9.62	5000	6000
3	7	17.08	7.51	6000	7000
3	4	18.10	11.44	7000	8000
3	3	21.14	13.00	8000	9000
3	3	13.45	14.15	9000	10000
3	3	14.63	9.82	10000	11000
3	5	17.19	9.65	11000	12000
3	6	16.80	8.47	12000	13000
3	4	15.90	4.98	13000	14000
3	5	13.83	8.94	14000	15000
3	12	20.69	8.32	15000	16000
3	6	11.30	6.77	16000	17000
3	1	16.10	0.00	17000	18000
3	10	19.28	7.16	18000	19000
3	6	16.51	6.88	19000	20000
3	4	16.81	6.11	20000	21000
3	3	20.56	4.11	21000	22000
3	4	18.71	9.36	22000	23000
3	6	21.43	4.16	23000	24000
3	8	17.62	8.44	24000	25000
3	4	13.08	10.72	25000	26000
3	12	13.93	6.64	26000	27000
3	24	16.30	7.87	27000	28000
3	16	15.26	9.37	28000	29000
3	72	16.89	8.10	29000	31000
3	110	17.40	7.97	31000	33000
3	78	18.04	8.50	33000	35000
3	38	15.45	8.82	35000	37000
3	20	14.50	7.89	37000	39000
3	7	17.53	10.89	39000	41000
3	1	17.33	0.00	41000	43000
3	1	14.27	0.00	43000	45000

Table B.1- 5: Density of the Aircraft to Aircraft Encounters (Part 5 for hour 4)

Hour	Count	Mean	Std Dev.	Lower Alt.	Upper Alt.
4	0			0	1000
4	0			1000	2000
4	0			2000	3000
4	4	19.04	7.23	3000	4000
4	5	14.67	9.79	4000	5000
4	11	16.65	7.46	5000	6000
4	11	18.14	8.85	6000	7000
4	2	27.96	1.70	7000	8000
4	4	21.95	6.33	8000	9000
4	0			9000	10000
4	7	13.04	7.93	10000	11000
4	3	13.38	10.64	11000	12000
4	2	16.39	12.95	12000	13000
4	4	13.56	7.80	13000	14000
4	1	27.48	0.00	14000	15000
4	9	17.71	8.25	15000	16000
4	8	18.89	6.97	16000	17000
4	13	20.93	4.69	17000	18000
4	12	15.16	7.16	18000	19000
4	4	14.26	9.07	19000	20000
4	4	19.41	5.20	20000	21000
4	6	18.43	8.23	21000	22000
4	5	13.12	5.48	22000	23000
4	8	21.10	5.98	23000	24000
4	7	19.74	8.23	24000	25000
4	12	15.61	4.73	25000	26000
4	15	15.39	6.98	26000	27000
4	33	16.16	7.79	27000	28000
4	30	18.25	9.08	28000	29000
4	132	15.19	8.67	29000	31000
4	73	16.07	7.88	31000	33000
4	74	15.70	9.23	33000	35000
4	20	13.73	8.56	35000	37000
4	8	12.13	7.82	37000	39000
4	9	13.40	7.47	39000	41000
4	1	0.59	0.00	41000	43000
4	0			43000	45000

Table B.1- 6: Density of the Aircraft to Aircraft Encounters (Part 6 for hour 5)

Hour	Count	Mean	Std Dev.	Lower Alt.	Upper Alt.
5	0			0	1000
5	0			1000	2000
5	0			2000	3000
5	1	16.35	0.00	3000	4000
5	0			4000	5000
5	5	21.93	7.04	5000	6000
5	1	12.62	0.00	6000	7000
5	2	22.30	7.59	7000	8000
5	0			8000	9000
5	1	15.02	0.00	9000	10000
5	1	3.84	0.00	10000	11000
5	4	12.33	6.93	11000	12000
5	0			12000	13000
5	0			13000	14000
5	0			14000	15000
5	2	16.99	0.36	15000	16000
5	4	16.13	11.08	16000	17000
5	2	18.62	1.98	17000	18000
5	1	6.39	0.00	18000	19000
5	0			19000	20000
5	2	18.64	6.93	20000	21000
5	3	18.76	5.43	21000	22000
5	1	17.05	0.00	22000	23000
5	2	16.74	16.66	23000	24000
5	2	4.49	4.73	24000	25000
5	0			25000	26000
5	3	23.42	7.05	26000	27000
5	8	15.62	8.91	27000	28000
5	9	20.42	4.48	28000	29000
5	29	11.64	8.26	29000	31000
5	17	10.84	7.71	31000	33000
5	21	17.16	10.36	33000	35000
5	8	15.11	9.28	35000	37000
5	0			37000	39000
5	3	12.24	10.37	39000	41000
5	0			41000	43000
5	0			43000	45000

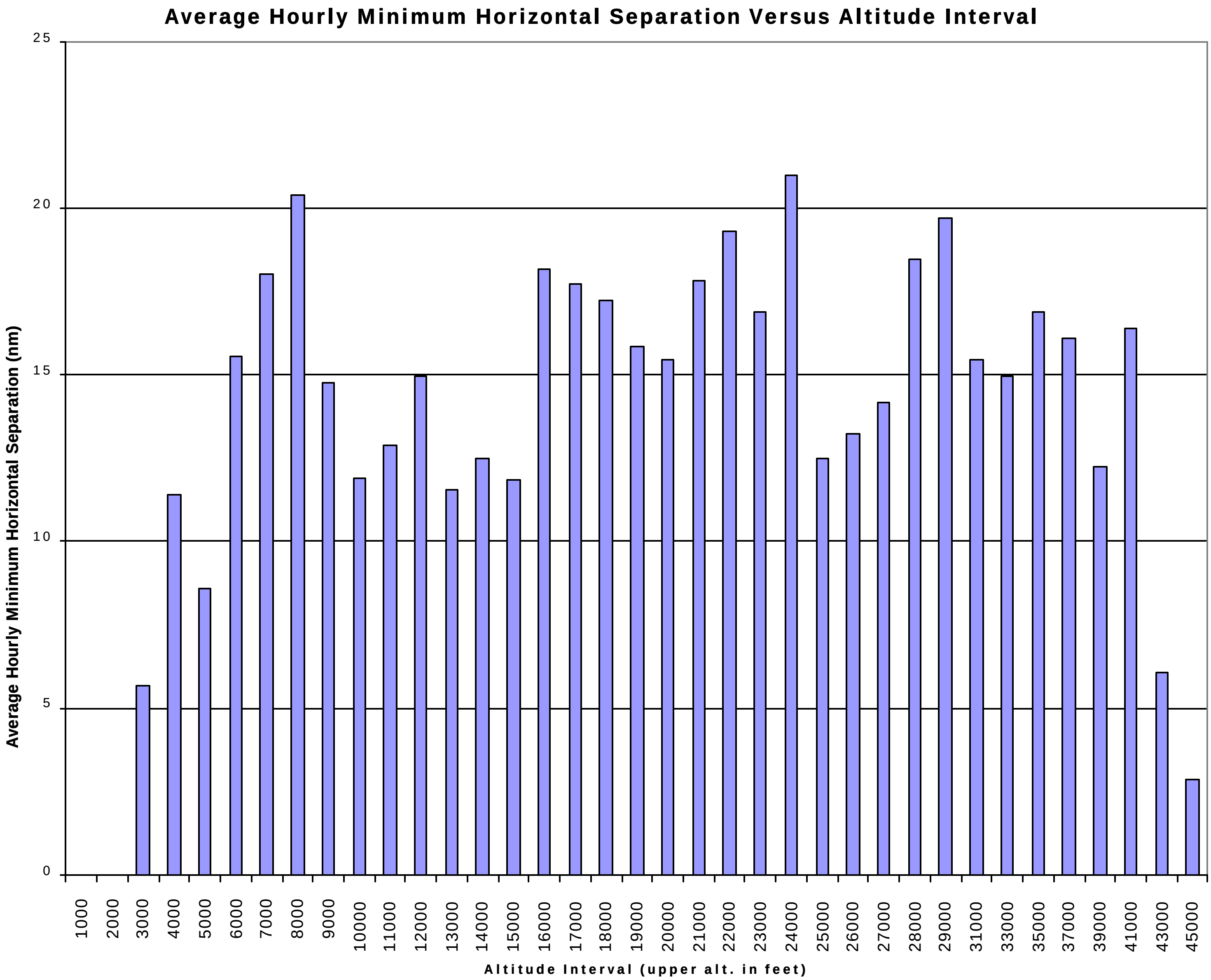

Figure B.1- 1: Average Minimum Horizontal Separation Per Hour Per Altitude Interval

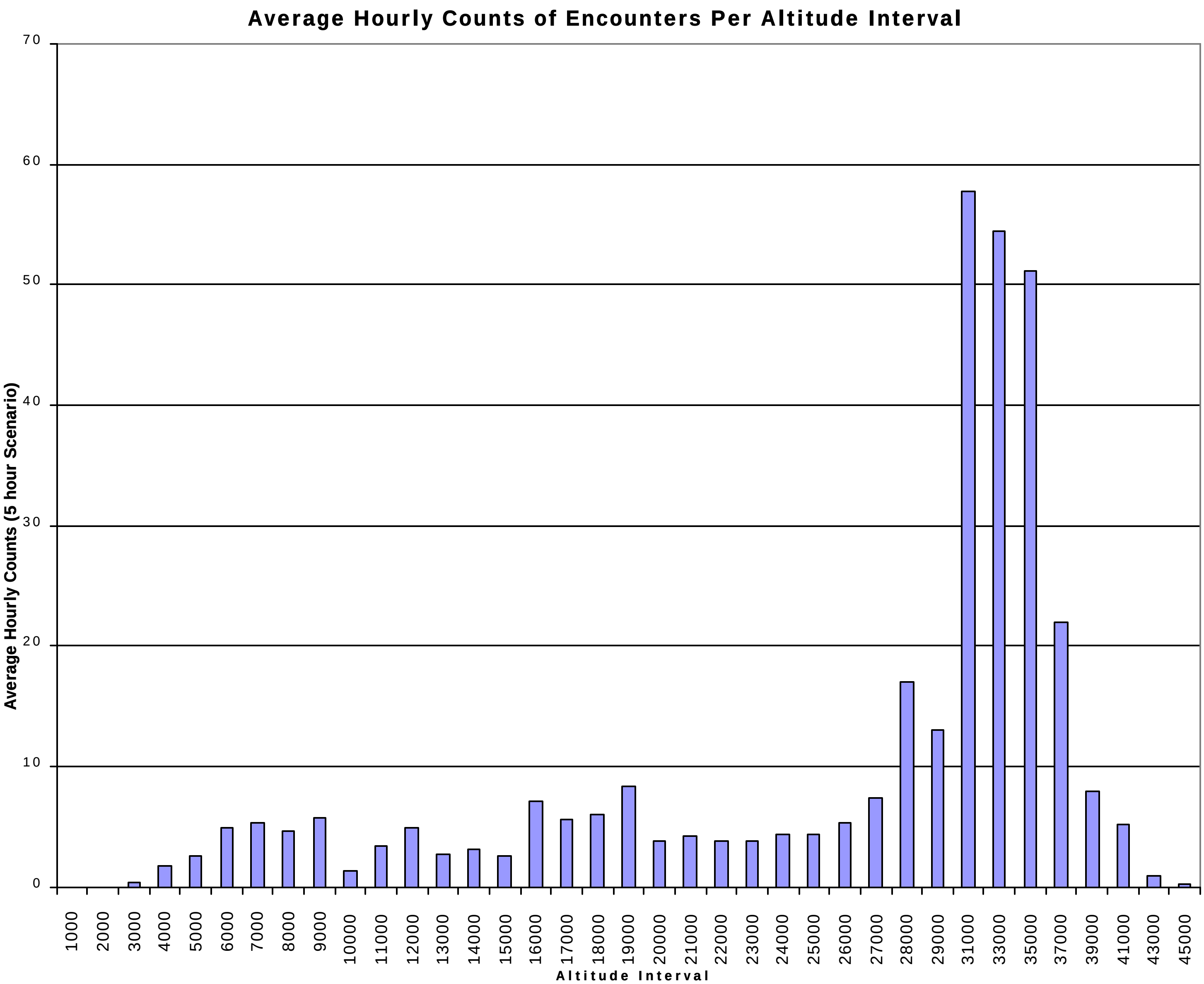

Figure B.1- 2: Average Hourly Counts for Encounters Per Altitude Interval

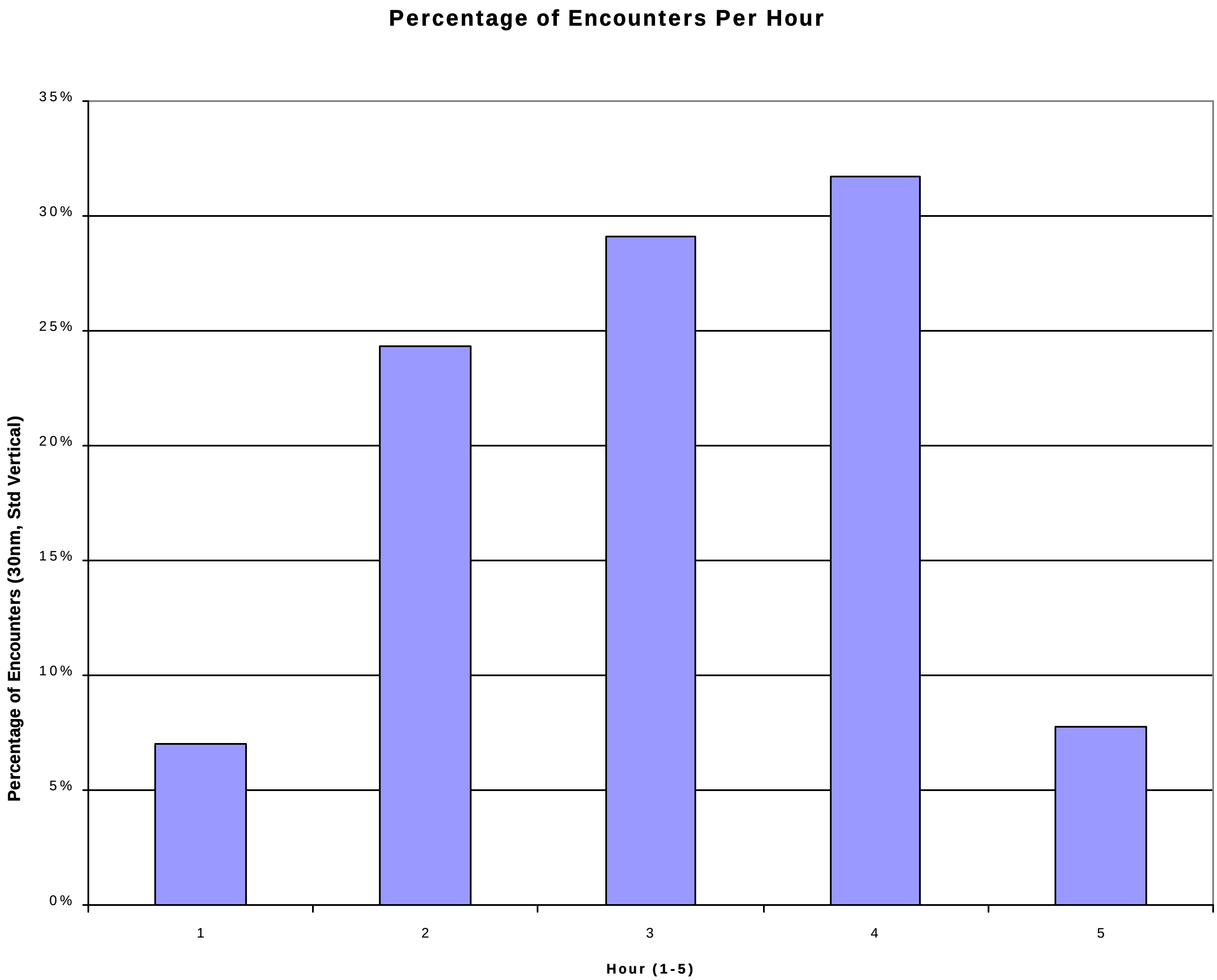

Figure B.1- 3: Percentage of Encounters at Minimum Horizontal Separations Per Hourly Interval

B.2. Rate of Flights per Minute

The rate of flights per minute described in Section 3.3.2.2 is presented below in Table B.2- 1. It is based on the same sample of 5 hours of traffic data from ZME collected on 5/26/99.

Table B.2- 1: Sample Rate of Flights per Minute

Statistic Description	Flight Count
Average Count per Minute	170.1
Standard Deviation Count per Minute	4
Maximum Count per Minute	258
Minimum Count per Minute	1
Median Count per Minute	194.5

The following Figure B.2- 1 presents the distribution of the number of active flights per minute over the sample 5 hour scenario.

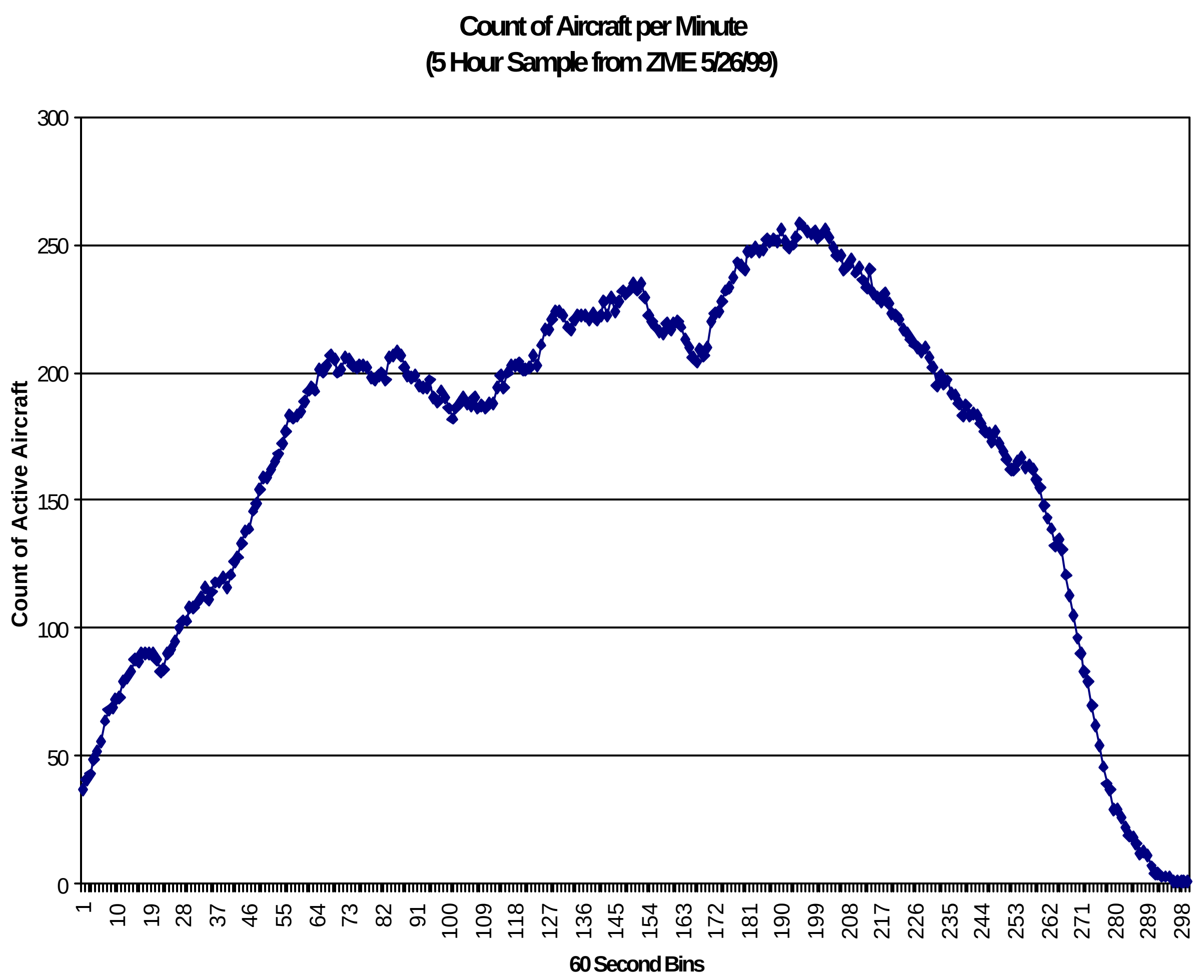

Figure B.2- 1: Distribution of Active Flights Count per Minute

B.3. Flight Type and Sector Penetration

As defined in Section 3.3.3, percentage of the various flight types, average number of sectors penetrated, average time within each sector, and average time within the entire center is calculated and presented in Table B.3- 1 for the 10 hour sample scenario. Note, for an aircraft to be included in these statistics the HCS track report must indicate the aircraft is under control by the center under study referred to as the SUT (i.e. ZME in this case).

Table B.3- 1: Flight Type & Sector Penetration

	Flight Type				
	Arrivals	**Departures**	**Internals**	**Overflights**	**All Types**
Average number of sectors penetrated	2.01	2.14	1.74	2.55	2.26
Average time in Center (minutes)	22.62	19.64	21.53	31.24	25.68
Average time in sector (minutes)	11.25	9.19	12.41	12.25	11.39
Percentage of flights per flight type	21.69	23.07	8.84	46.40	100.00

B.4. Aircraft Ground Speed per Altitude Interval

Described in Section 3.3.4, the average ground speed is reported per altitude interval. The altitude intervals are defined in Section 3.3.1, which was also used in the aircraft density statistics. The ground speed is calculated by determining the sample mean reported in the post process HCS track reports per altitude interval. The average ground speeds per altitude interval are presented in Figure B.4- 1.

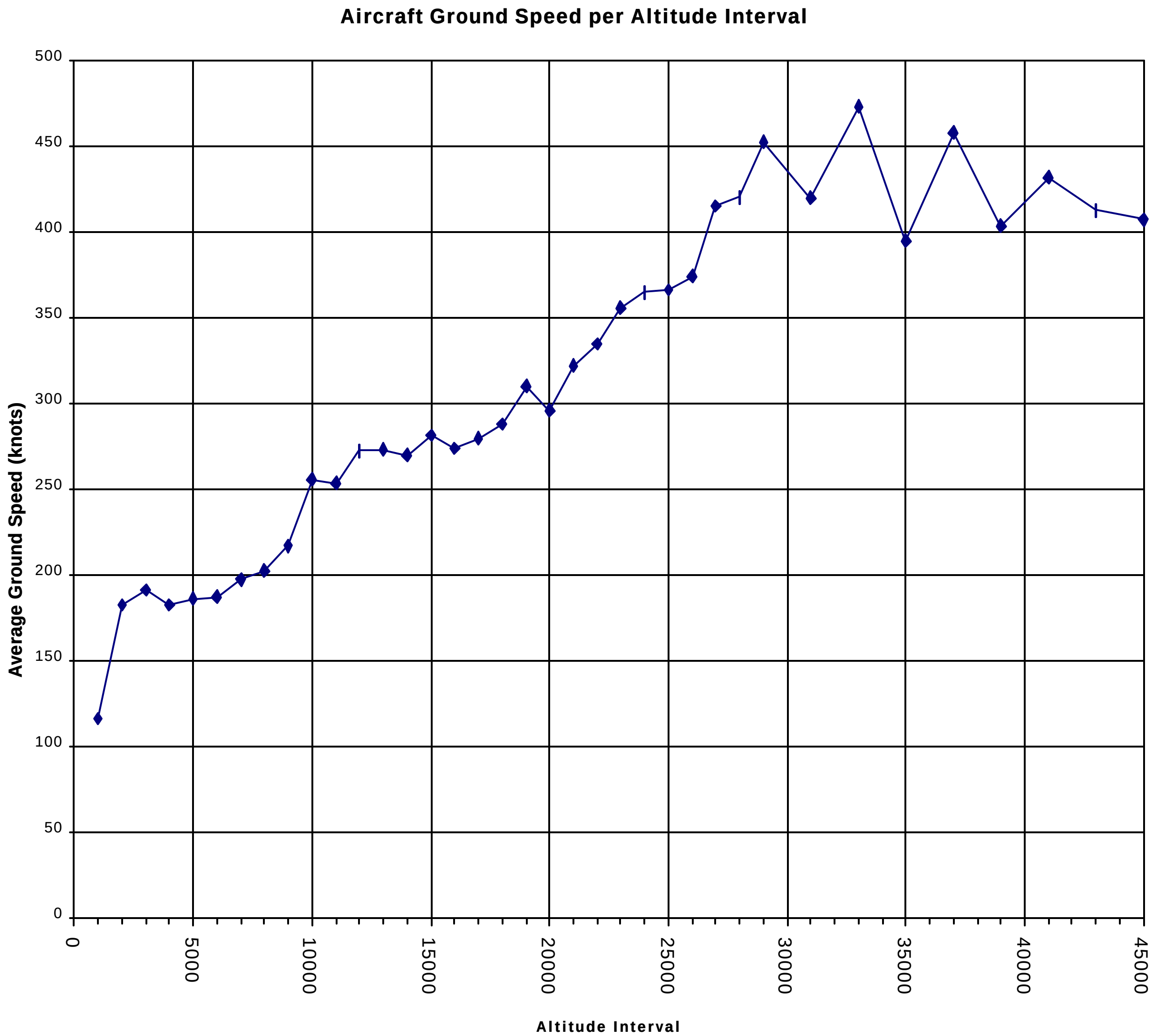

Figure B.4- 1: Average Ground Speed per Altitude Interval

Appendix C: Aircraft Distributions for Preliminary Sample

The purpose of this appendix is to provide the reader with a preliminary view of potential characteristics of the accuracy scenarios and give additional insights in how the characteristics will be calculated. The tables and figures from Appendix C represent sample data from a 10 hour sample of traffic data. The source of the traffic data is from ZME collected on May 26, 1999 (same as Appendix A and B).

In Sections C.1, C.2, C.3, and C.4 that follow, the frequency of flights as a function of aircraft type, models, equipage, and airline carriers are reported, respectively, for the 10 hour sample scenario.

ACT-250 does caution the reader that the following data is presented using untested versions of our software tools, so may contain some inaccuracies. Even under this assumption, the preliminary data does provide an adequate preview of what should be expected in the final scenarios.

C.1. Aircraft Type Distribution

As described in Section 3.4.1, the aircraft type distribution for the sample scenario are reported in the following Table C.1- 1.

Table C.1- 1: Aircraft Type of Sample Scenario

Engine Type	Percentage in Scenario	Description of Engine Type
J	67.50%	Jet
T	18.94%	Turboprop
P	13.09%	Piston
U	0.33%	Unknown
H	0.14%	Helicopter

C.2. Aircraft Models

Table C.2- 1 lists the model code and the percentage of flights that had this model type in the 10 hour sample scenario.

Table C.2- 1: Model Types in Sample Scenario

Model Type	Percentage	Cum. Percentage
MD80	9.40%	9.40%
DC9Q	4.95%	14.35%
B733	4.84%	19.20%
SF34	4.19%	23.39%
B752	3.65%	27.04%
B722	3.54%	30.59%
BE20	3.07%	33.66%
DC9	2.86%	36.51%
BE58	2.60%	39.12%
B72Q	2.35%	41.47%
CARJ	2.24%	43.71%
B735	2.17%	45.88%
F100	2.06%	47.94%
BE9L	1.84%	49.78%
A320	1.77%	51.55%
B732	1.45%	53.00%
C560	1.37%	54.37%
B73Q	1.34%	55.71%
E145	1.30%	57.01%
B737	1.27%	58.28%
C650	1.23%	59.51%
LJ35	1.08%	60.59%
BE40	1.05%	61.64%
C550	1.05%	62.69%
H25B	1.05%	63.74%
PA31	1.05%	64.79%
B190	1.01%	65.80%
B763	0.90%	66.70%
E120	0.90%	67.61%
FA20	0.90%	68.51%
C210	0.83%	69.34%
BE36	0.76%	70.10%
BE55	0.76%	70.86%
MU2	0.76%	71.62%
C310	0.72%	72.34%
A306	0.61%	72.96%
BE30	0.61%	73.57%
JS32	0.61%	74.19%
BA46	0.54%	74.73%
C421	0.54%	75.27%
CL60	0.54%	75.81%
PA32	0.54%	76.36%
B734	0.51%	76.86%

DC10	0.51%	77.37%
JS41	0.51%	77.87%
BE35	0.47%	78.34%
GLF4	0.47%	78.81%
C441	0.43%	79.25%
LJ31	0.43%	79.68%
WW24	0.43%	80.12%
C501	0.40%	80.51%
C525	0.40%	80.91%
FA10	0.40%	81.31%
L101	0.40%	81.71%
AT45	0.36%	82.07%
B762	0.36%	82.43%
C208	0.36%	82.79%
C500	0.36%	83.15%
GLF2	0.36%	83.51%
LJ25	0.36%	83.88%
LJ60	0.36%	84.24%
PAY2	0.36%	84.60%
SBR1	0.36%	84.96%
C182	0.33%	85.29%
C340	0.33%	85.61%
C414	0.33%	85.94%
H25A	0.33%	86.26%
LJ24	0.33%	86.59%
AC90	0.29%	86.88%
B727	0.29%	87.17%
BE10	0.29%	87.45%
DC87	0.29%	87.74%
P32R	0.29%	88.03%
PA34	0.29%	88.32%
PC12	0.29%	88.61%
ASTR	0.25%	88.86%
AT72	0.25%	89.12%
FA50	0.25%	89.37%
B350	0.22%	89.59%
C172	0.22%	89.80%
C750	0.22%	90.02%
DC86	0.22%	90.24%
DC8Q	0.22%	90.46%
JS31	0.22%	90.67%
LJ55	0.22%	90.89%
LR35	0.22%	91.11%
M20	0.22%	91.32%
PA46	0.22%	91.54%
PAY1	0.22%	91.76%
SW3	0.22%	91.97%
SW4	0.22%	92.19%
A319	0.18%	92.37%
AEST	0.18%	92.55%
B772	0.18%	92.73%
BE33	0.18%	92.91%
BE90	0.18%	93.09%

BE99	0.18%	93.28%
CL65	0.18%	93.46%
HS25	0.18%	93.64%
MD90	0.18%	93.82%
SH33	0.18%	94.00%
A310	0.14%	94.14%
AC69	0.14%	94.29%
AT43	0.14%	94.43%
C177	0.14%	94.58%
C402	0.14%	94.72%
F2TH	0.14%	94.87%
GLF3	0.14%	95.01%
H60	0.14%	95.16%
LJ45	0.14%	95.30%
P28R	0.14%	95.44%
P31T	0.14%	95.59%
PA27	0.14%	95.73%
AC50	0.11%	95.84%
B721	0.11%	95.95%
B738	0.11%	96.06%
BE18	0.11%	96.17%
BE9T	0.11%	96.28%
C141	0.11%	96.38%
CL64	0.11%	96.49%
LR25	0.11%	96.60%
MD11	0.11%	96.71%
PA24	0.11%	96.82%
PA28	0.11%	96.93%
A340	0.07%	97.00%
AC6T	0.07%	97.07%
AC95	0.07%	97.14%
B73B	0.07%	97.22%
BE60	0.07%	97.29%
C17	0.07%	97.36%
C401	0.07%	97.43%
C82R	0.07%	97.51%
D328	0.07%	97.58%
F900	0.07%	97.65%
GC1	0.07%	97.72%
GLF5	0.07%	97.79%
H25C	0.07%	97.87%
M20T	0.07%	97.94%
MXT7	0.07%	98.01%
P210	0.07%	98.08%
P28A	0.07%	98.16%
PA44	0.07%	98.23%
PAY3	0.07%	98.30%
SH36	0.07%	98.37%
SW2	0.07%	98.45%
A300	0.04%	98.48%
AA5	0.04%	98.52%
AC11	0.04%	98.55%
AC70	0.04%	98.59%

AC9T	0.04%	98.63%
B55	0.04%	98.66%
B742	0.04%	98.70%
B744	0.04%	98.73%
BE65	0.04%	98.77%
BE76	0.04%	98.81%
BE95	0.04%	98.84%
BL17	0.04%	98.88%
C180	0.04%	98.92%
C335	0.04%	98.95%
C337	0.04%	98.99%
C425	0.04%	99.02%
C551	0.04%	99.06%
CV58	0.04%	99.10%
CVLT	0.04%	99.13%
DA20	0.04%	99.17%
DC8	0.04%	99.20%
DC85	0.04%	99.24%
FJ50	0.04%	99.28%
G159	0.04%	99.31%
L29A	0.04%	99.35%
L29B	0.04%	99.39%
L329	0.04%	99.42%
LJ23	0.04%	99.46%
LR24	0.04%	99.49%
LR60	0.04%	99.53%
M20P	0.04%	99.57%
MO20	0.04%	99.60%
MU2B	0.04%	99.64%
MU3	0.04%	99.67%
MU30	0.04%	99.71%
P12	0.04%	99.75%
P180	0.04%	99.78%
P28B	0.04%	99.82%
PA23	0.04%	99.86%
PAY4	0.04%	99.89%
PAYE	0.04%	99.93%
T2	0.04%	99.96%
TRIN	0.04%	100.00%

C.3. Aircraft Equipage

The aircraft equipage code in the flight plan determines what navigation equipment is available for the particular flight described in Section 3.4.3. Table C.3- 1 lists the percentage of flights with the particular equipage code in the 10 hour sample scenario. From this list and sample, 31 percent of the flights are non-navigational equipped and 69 percent are.

Table C.3- 1: Equipage Frequency

Equipage Code	Percentage of Flights
A	29.86%
I	24.51%
G	19.27%
E	11.53%
F	10.20%
R	3.15%
U	0.90%
W	0.51%
B	0.04%
P	0.04%

C.4. Airline Distributions

The following Table C.4- 1 lists the airline codes and their percentage of flights in the 10 hour sample scenario.

Table C.4- 1: Airline Frequency

Airline Code	Percentage
GEN[13]	35.83%
DAL	9.47%
AAL	6.69%
NWA	6.65%
SWA	5.06%
COA	4.19%
FLG	3.83%
TWA	3.25%
USA	3.00%
UAL	2.68%
FDX	1.52%
ASE	1.37%
EGF	1.16%
COM	1.08%
BTA	1.01%
AMW	0.94%
PGX	0.94%
LOF	0.90%
TRS	0.69%
AMT	0.65%
MES	0.54%
ABX	0.51%
UPS	0.51%
ASH	0.40%
EWW	0.40%
KHA	0.40%
PAT	0.40%
ACA	0.33%
EJA	0.33%
CHQ	0.25%
RLT	0.25%
MXA	0.22%
RCH	0.22%
SPG	0.22%
AJI	0.18%
AWI	0.18%
CEA	0.18%
LN9	0.18%
AWE	0.14%
BLR	0.14%
BSY	0.14%
MEP	0.14%
AMF	0.11%

[13] GEN is general aviation aircraft not a particular airline.

AMX	0.11%
BKA	0.11%
EJM	0.11%
FCI	0.11%
FLC	0.11%
G23	0.11%
GAE	0.11%
KHC	0.11%
LN1	0.11%
LN4	0.11%
VGD	0.11%
ATN	0.07%
BAW	0.07%
BVN	0.07%
CDN	0.07%
CKS	0.07%
DLH	0.07%
FFT	0.07%
JIA	0.07%
RYN	0.07%
SYX	0.07%
USC	0.07%
AFR	0.04%
AJM	0.04%
BSK	0.04%
CCI	0.04%
CCP	0.04%
E62	0.04%
FBF	0.04%
IBY	0.04%
LN2	0.04%
M54	0.04%
MDC	0.04%
MRA	0.04%
R26	0.04%
S30	0.04%
SCX	0.04%
SKQ	0.04%
TCN	0.04%
TMM	0.04%
TSU	0.04%
VV0	0.04%
VV4	0.04%

Appendix D: Default Parameter List

This appendix contains the list of default parameters, their values, and section references in the body of this document. The list may not be the total list of parameters required to build the accuracy scenarios, but the list includes the significant parameters discussed in this document. The values are the current values at the publish date of this document and are subject to some change in the future.

Table D.1 1: Parameter List

Name/Description	Values	Section References
Conflict and encounter standard vertical separation	1000 feet at or below FL290 and 2000 feet above	3.2, 3.2.1
Conflict standard horizontal separation	5 nautical miles	3.2, 3.2.1
Encounter horizontal separation	30 nautical miles	3.2, 3.2.1
RDTRACKS large track gap threshold	120 seconds	3.2, 3.2.2.3
Track conflict/encounter gross filter horizontal threshold	35 nautical miles	3.2
Track conflict/encounter gross filter vertical threshold	3000 feet	3.2
Combine multiple conflict interval	5 minutes	3.2, 3.2.2.3
Negligible short conflict/encounter interval	10 seconds	3.2
Allowable cruise altitude deviation	300 feet	3.2
Time threshold for pop-up missed alert exclusion	5 minutes	3.2
Current plan adherence age requirement	13 minutes	3.2.1, 3.2.2
Trial plan adherence age requirement	23 minutes	3.2.1, 3.2.2
Current plan aircraft to aircraft encounter count table	Refer to Table 3.2-1	3.2.1.1
Trial plan aircraft to aircraft encounter count table	Refer to Table 3.2-2	3.2.1.1
ACT-250 upper bound on Table 3.2-1, Table 3.2-2, Table 3.2-3, and Table 3.2-4	30 nautical miles	3.2.1.1, 3.2.2.1
Altitude interval for encounter count per altitude statistics	1000 feet at/below FL290 and 2000 feet above	3.2.1.2
Encounter angle increment (aircraft to aircraft)	45 degrees	3.2.1.3
Encounter angle interval (aircraft to aircraft)	0 to 180 degrees	3.2.1.3
Vertical Phase of flight 10 second transition rate (for Approach 2)	10 to 150 feet	3.2.1.3
Vertical Phase of flight for encounter sample time threshold at minimum horizontal separation point (for Approach 2)	+/- 10 seconds	3.2.1.3
Current plan aircraft to aircraft encounter count table	Refer to Table 3.2-3	3.2.2.1
Trial plan aircraft to aircraft encounter count table	Refer to Table 3.2-4	3.2.2.1
Encounter angle increment (aircraft to airspace)	30 degrees	3.2.2.3
Encounter angle interval (aircraft to airspace)	0 to 90 degrees	3.2.2.3
Post processed track report interval (by interpolation)	10 seconds	3.2.2.3
Default adherence age at first track and after flight plan amendment	Infinity seconds	3.5
Default adherence age after large gap	0 seconds	3.5
Equipage codes for navigational equipped aircraft	C, R, I, W, G, E, and F	3.4.3
Turn fix angle on route	30 degrees	3.5.1
Track point distance to be associated to turn fix	15 nautical miles	3.5.1
Current lateral deviation thresholds	Refer to Table 3.5-1	3.5.1
Vertical adherence threshold below FL 290	300 feet	3.5.2

Vertical adherence threshold at or above FL 290	500 feet	3.5.2
Vertical modeling accuracy, TRAJ_SAMPLE_TIME	30 seconds	3.8
Vertical modeling accuracy, TRAJ_DELTA_TIME	36 seconds	3.8
Vertical modeling accuracy, TRAJ_LOOKAHEAD_WIN	780 seconds	3.8
Vertical modeling accuracy, TRAJ_LOOKAHEAD_TIME	10 seconds	3.8
General track-trajectory deviation[14], TRAJ_SAMPLE_TIME	120 seconds	No reference in this document
General track-trajectory deviation, TRAJ_DELTA_TIME	36 seconds	No reference in this document
General track-trajectory deviation, TRAJ_LOOKAHEAD_WIN	1200 seconds	No reference in this document
General track-trajectory deviation, TRAJ_LOOKAHEAD_TIME	300 seconds	No reference in this document

[14] The track to trajectory deviation is not discussed in any detail in this document but will be calculated by ACT-250 as input to the specification refresh using the generated accuracy scenarios. The thresholds are only included here for the sake of completeness. See Reference [10] for complete definition of these variables.